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Lake Brownwood
Brown County, Texas

National Eutrophication Survey, Corvallis, Oreg

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NATIONAL EUTROPHICATION SURVEY

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REPORT

ON

LAKE BROWNWOOD

BROWN COUNTY

TEXAS

EPA REGION VI

WORKING PAPER No. 635

WITH THE COOPERATION OF THE

TEXAS WATER QUALITY BOARD

AND THE

TEXAS NATIONAL GUARD

FEBRUARY, 1977

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16. ABSTRACT:

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGEMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Texas Water Quality Board for professional involvement, to the Texas National Guard for conducting the tributary sampling phase of the Survey, and to those Texas wastewater treatment plant operators who voluntarily provided effluent samples.

Hugh C. Yantis, Jr., Executive Director of the Texas Water Quality Board, and John B. Latchford, Jr., Director, and the staff of the Field Operations Division provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

Major General Thomas Bishop, the Adjutant General of Texas, and Project Officer Colonel William L. Seals, who directed the volunteer efforts of the Texas National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY RESERVOIRS

State of Texas

NAME	COUNTY
Amistad	Val Verde
Bastrop	Bastrop
Belton	Bell, Coryell
Braunig	Bexar
Brownwood	Brown
Buchanan	Burnet, Llano
Caddo	Harrison, Marion, TX; Caddo Parish, LA
Calaveras	Bexar
Canyon	Comal
Colorado City	Mitchell
Corpus Christi	Jim Wells, Live Oak, San Patricio
Diversion	Archer, Baylor
Eagle Mountain	Tarrant, Wise
Fort Phantom Hill	Jones
Houston	Harris
Kemp	Baylor
Lake O'The Pine.	Camp, Marion, Morris, Upshur
Lavon	Collin
Lewisville (Garza-Little Elm)	Denton
Livingston	Polk, San Jacinto, Trinity, Walker

Lyndon B. Johnson	Burnet, Llano
Medina	Bandera, Medina
Meredith	Hutchinson, Moore, Potter
O. C. Fisher (San Angelo)	Tom Green
Palestine	Anderson, Cherokee, Henderson, Smith
Possum Kingdom	Palo Pinto, Stephens, Young
Sam Rayburn	Angelina, Jasper Nacogdoches, Sabine, San Augustine
Somerville	Burleson, Lee, Washington
E. V. Spence	Coke
Stamford	Haskell
Stillhouse Hollow	Bell
Tawakoni	Hunt, Rains, Van Zandt
Texoma	Cooke, Grayson TX; Bryan, Johnston, Love, Marshall, OK
Travis	Burnet, Travis
Trinidad	Henderson
Twin Buttes	Tom Green
White River	Crosby
Whitney	Bosque, Hill
Wright Patman (Texarkana)	Bowie, Cass

LAKE MICHIGAN

LAKE BROWNWOOD

STORET NO. 4805

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Lake Brownwood is eutrophic; i.e., well supplied with nutrients and quite productive. Whether nutrient enrichment is beneficial or deleterious depends on the actual or potential effect on the uses of the lake. In this regard, the Texas Water Quality Board has indicated that there is little or no known impairment of the designated beneficial uses of this lake.

Lake Brownwood ranked sixth in overall trophic quality when the 39 Texas reservoirs sampled in 1974 were compared using a combination of six parameters*. Thirteen of the reservoirs had less median total phusphorus, two had less and five had the same median dissolved phosphorus, eleven had less and one had the same median inorganic nitrogen, five had less mean chlorophyll a, and 27 had greater mean Secchi disc transparency. Marked depression of dissolved oxygen with depth occurred at station 1 in August.

Survey limnologists did not observe algal concentrations or macrophytes during their sampling visits.

B. Rate-Limiting Nutrient:

The results of the algal assay indicate phosphorus was the rate-limiting nutrient at the time the sample was collected (03/07/74).

* See Appendix A.

The lake data indicate phosphorus limitation in March and May but nitrogen limitation in August and October.

C. Nutrient Controllability:

1. Point sources--No known municipal or industrial point sources impacted Lake Brownwood during the sampling year. Septic tanks serving lakeshore dwellings and recreation areas were estimated to have contributed 2% of the total phosphorus load to the lake, but a shoreline survey would be needed to determine the significance of these sources.

The present phosphorus loading of 0.29 g/m^2/yr is less than that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic loading but is more than his suggested oligotrophic loading (see page 12).

2. Non-point sources--The non-point phosphorus load, including precipitation, amounted to 98.0% of the total load reaching the lake. Jim Ned Creek contributed 53.2% of the total, Pecan Bayou added 22.6%, and ungaged tributaries contributed an estimated 16.2% of the total.

The non-point phosphorus exports of Jim Ned Creek and Pecan Bayou were 3 and 1 kg/km^2/yr, respectively (see page 11). These export rates are quite comparable to the rate of a tributary of nearby Lake Colorado City* (1 kg/km^2/yr) but higher than a tributary of O. C. Fisher Reservoir** (<1 kg/km^2/yr).

* Working Paper No. 640.
** Working Paper No. 656.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS[†]

A. Lake Morphometry[††]:

1. Surface area: 29.56 kilometers^2.

2. Mean depth: 6.0 meters.

3. Maximum depth: >16.8 meters.

4. Volume: 177,240 x 10^5 m^3.

5. Mean hydraulic retention time: 1.5 years (based on outflow).

B. Tributary and Outlet.
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Pecan Bayou	1,623.9	2.000
Jim Ned Creek	1,634.3	2.003
Minor tributaries & immediate drainage -	687.9	0.890
Totals	3,946.1	4.893

2. Outlet -

Brownwood Aqueduct	0.0	0.750
Pecan Bayou	3,975.6	2.894
Totals	3,975.6**	3.644

C. Precipitation***:

1. Year of sampling: 74.2 centimeters.

2. Mean annual: 59.6 centimeters.

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† Table of metric conversions--Appendix B.
†† Latchford, 1974.
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
** Includes area of lake.
*** See Working Paper No. 175.

III. LAKE WATER QUALITY SUMMARY

Lake Brownwood was sampled four times during 1974 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from four stations on the lake and from two or more depths at each station (see map, page vi). During each visit, a single depth-integrated (4.6 m or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first visit, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 16.8 meters at station 1, 8.2 meters at station 2, 3.0 meters at station 3, and 9.1 meters at station 4.

The sampling results are presented in full in Appendix B and are summarized in the following table.

A SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR BRUNSWICK LAKE
STUDY CODE: WHIS

PARAMETER	1ST SAMPLING : 27 MAY - SITES			2ND SAMPLING : 5/29/74 - SITES			3RD SAMPLING : 6/ 2/74 - SITES		
	RANGE	MEAN	MEDIAN	RANGE	MEAN	MEDIAN	RANGE	MEAN	MEDIAN
TEMP (C)	11.7 - 18.1	14.9	15.3	23.3 - 25.9	24.5	24.7	24.2 - 26.5	25.4	25.1
DISS OXY (MG/L)	4.1 - 11.1	9.3	9.4	4.4 - 7.1	5.4	7.0	5.0 - 9.1	7.1	6.8
CONDUCTIVITY (MICROMHOS)	478. - 548.	504.	504.	465. - 545.	494.	494.	484. - 494.	491.	494.
PH (STAND UNITS)	6.2 - 6.6	6.3	6.3	7.9 - 8.3	8.2	8.2	7.7 - 8.3	8.1	8.1
TOT ALK (MG/L)	121. - 131.	125.	125.	111. - 124.	120.	124.	118. - 132.	122.	121.
TOT P (MG/L)	0.010 - 0.071	0.025	0.023	0.017 - 0.083	0.036	0.029	0.024 - 0.074	0.039	0.031
DISTHO P (MG/L)	0.004 - 0.015	0.007	0.006	0.005 - 0.010	0.007	0.007	0.002 - 0.011	0.006	0.006
NO2+NO3 (MG/L)	0.05 - 0.07	0.07	0.07	0.03 - 0.06	0.05	0.05	0.03 - 0.06	0.04	0.03
AMMONIA (MG/L)	0.03 - 0.07	0.03	0.03	0.03 - 0.06	0.04	0.04	0.03 - 0.13	0.05	0.04
KJEL N (MG/L)	0.39 - 0.70	0.49	0.46	0.38 - 0.48	0.43	0.43	0.29 - 0.48	0.34	0.33
ORGNC N (MG/L)	0.37 - 0.63	0.47	0.44	0.34 - 0.40	0.36	0.36	0.24 - 0.36	0.29	0.28
TOTAL N (MG/L)	0.39 - 0.70	0.52	0.49	0.34 - 0.46	0.42	0.39	0.29 - 0.48	0.39	0.38
CHLOPHYL A (UG/L)	0.4 - 2.2	1.1	0.9	1.4 - 4.7	3.2	3.4	0.4 - 12.4	5.3	4.1
SECCHI (METERS)	0.5 - 1.4	1.0	1.0	0.1 - 0.4	0.3	0.3	0.1 - 1.5	0.4	0.4

[illegible]

[illegible]

PARAMETER	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

6. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
03/07/74	1. Chroomonas sp.	618
	2. Flagellates	172
	3. Ankistrodesmus sp.	137
	4. Nitzschia sp.	137
	5. Cryptomonas sp.	103
	Other genera	240
	Total	1,407
05/16/74	1. Nitzschia sp.	919
	2. Cryptomonas sp.	238
	3. Chlamydomonas sp.	204
	4. Chroomonas sp.	170
	5. Lyngbya sp.	136
	Other genera	410
	Total	2,077
08/06/74	1. Lyngbya sp.	1,277
	2. Oscillatoria sp.	998
	3. Raphidiopsis sp.	399
	4. Nitzschia sp.	399
	5. Cryptomonas sp.	319
	Other genera	599
	Total	3,991
10/29/74	1. Chlamydomas sp.	204
	2. Chroomonas sp.	204
	3. Cryptomonas sp.	204
	4. Cyclotella sp.	58
	5. Gymnodinium sp.	58
	Other genera	291
	Total	1,019

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (ug/l)
03/07/74	1	0.7
	2	0.6
	3	2.2
	4	1.0
05/16/74	1	2.2
	2	1.3
	3	4.6
	4	4.7
08/06/74	1	6.1
	2	10.6
	3	12.9
	4	7.5
10/29/74	1	6.5
	2	3.8
	3	8.8
	4	4.6

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.005	0.112	0.1
0.050 P	0.055	0.112	2.8
0.050 P + 1.0 N	0.055	1.112	15.3
1.0 N	0.005	1.112	0.1

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity

of Lake Brownwood was low when the sample was taken in March, 1974. Also, the significant increase in yield when orthophosphorus was added and the lack of response to nitrogen added alone indicate phosphorus limitation.

The lake data indicate phosphorus limitation in March and in May (the mean inorganic nitrogen/orthophosphorus ratio was 14/1 at those times). However, nitrogen limitation is indicated in August and October; i.e., the mean N/P ratios were 11/1 and 10/1, respectively, and nitrogen limitation would be expected.

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Texas National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page vi), except for the high runoff months of April and May when two samples were collected. Sampling was begun in September, 1974, and was completed in July, 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Texas District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*.

Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the means of the nutrient loads, in $kg/km^2/year$, at stations A-2 and C-1 and multiplying the means by the ZZ area in km^2.

No known wastewater treatment plants impacted Lake Brownwood during the sampling year.

* See Working Paper No. 175.

A. Waste Sources:

1. Known municipal - None

2. Known industrial - None

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/ yr	% of total
a. Tributaries (non-point load) -		
Pecan Bayou	1,925	22.6
Jim Ned Creek	4,630	53.2
b. Minor tributaries & immediate drainage (non-point load) -	1,375	16.2
c. Known municipal STP's - None	-	-
d. Septic tanks* -	170	2.0
e. Known industrial - None	-	-
f. Direct precipitation** -	515	6.0
Total	8,515	100.0

2. Outputs -

Lake outlet -	Brownwood Aqueduct	500
	Pecan Bayou	2,475
	Total	2,975

3. Net annual P accumulation - 5,540 kg.

* Estimate based on 575 lakeshore dwellings, 2 campgrounds, and 1 park; see Working Paper No. 175.
** See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (non-point load) -		
Pecan Bayou	88,965	37.8
Jim Ned Creek	74,055	31.4
b. Minor tributaries & immediate drainage (non-point load) -	34,395	14.6
c. Known municipal STP's - None	-	-
d. Septic tanks* -	6,305	2.7
e. Known industrial - None	-	-
f. Direct precipitation** -	31,890	13.5
Total	235,640	100.0

2. Outputs -

Lake outlet -	Brownwood Aqueduct	12,865
	Pecan Bayou	73,050
	Total	85,915

3. Net annual N accumulation - 149,725 kg.

D. Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km²/yr	kg N/km²/yr
Pecan Bayou	1	55
Jim Ned Creek	3	45

* Estimate based on 575 lakeshore dwellings, 2 campgrounds, and 1 park; see Working Paper No. 175.
** See Working Paper No. 175.

E. Mean Nutrient Concentrations in Ungaged Streams:

Tributary	Mean Total P Conc. (mg/l)	Mean Total N Conc. (mg/l)
Hog Creek	0.063	1.122
Rough Branch	0.021	1.014

F. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	0.29	0.19	8.0	5.1

Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Lake Brownwood:

"Dangerous" (eutrophic loading)	0.40
"Permissible" (oligotrophic loading)	0.20

V. LITERATURE REVIEWED

Latchford, John B. Jr., 1974. Personal communication (lake morphometry). TX Water Qual. Bd., Austin.

Vollenweider, R. A., and P. J. Dillon, 1974. The application of the phosphorus loading concept to eutrophication research. Natl. Res. Council of Canada Publ. No. 13690, Canada Centre for Inland Waters, Burlington, Ontario.

Yost, I. D., 1976. Personal communication (estimate of evaporation at Brownwood Reservoir). U.S. Geol. Surv., Austin.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN PARAMETRIC

LAKE CODE	LAKE NAME	[illegible] TOTAL P	[illegible] INFLOW N	[illegible] SED REL	[illegible] DELIVERY	[illegible] AVG LD	[illegible] LOSS RATIO P
4001	AMISTAD LAKE	0.011	0.506	371,474	2,042	14,401	0.004
4002	BASTROP LAKE	0.027	0.496	435,417	12,342	15,481	0.007
4003	BELTON RESERVOIR	0.016	0.1**	376,312	8,825	15,488	0.007
4004	BRAUNIG LAKE	0.134	0.458	481,625	22,782	14,488	0.002
4005	BROWNWOOD LAKE	0.027	0.186	435,175	4,887	14,481	0.007
4006	LAKE [illegible]	0.036	0.256	437,673	5,686	15,288	0.002
4007	CADDO LAKE	0.056	0.878	463,333	14,884	11,488	0.001
4008	CALAVERAS LAKE	0.036	0.886	481,967	22,588	13,885	0.007
4009	CANYON RESERVOIR	0.738	0.458	384,612	2,588	14,888	0.006
4010	LAKE COLORADO CITY	0.042	0.298	473,625	12,675	18,286	0.002
4011	CORPUS CHRISTI LAKE	0.113	0.138	435,197	15,756	14,748	0.058
4012	DIVERSION LAKE	0.025	0.888	478,111	15,887	0.184	0.009
4013	EAGLE MOUNTAIN LAKE	0.024	0.878	485,625	5,682	13,846	0.888
4014	FT PHANTOM HILL LAKE	0.068	2.185	474,784	6,317	6,485	0.022
4015	GARZA LITTLE ELM RESERVE	0.045	0.388	435,782	14,156	14,488	0.016
4016	[illegible] LAKE	0.023	0.138	485,891	18,217	18,488	0.887
4017	HOUSTON LAKE	0.097	1.248	486,387	16,658	12,488	0.036
4018	LAKE OF THE PINES	0.031	0.598	448,888	18,819	15,888	0.011
4019	LAVON RESERVOIR	0.087	0.198	485,331	5,488	8,888	0.029
4020	LIVINGSTON LAKE	0.196	0.555	485,484	16,112	15,888	0.124
4021	LYNDON B JOHNSON LAKE	0.042	0.428	484,588	8,188	14,485	0.013
4022	MEDINA LAKE	0.018	0.686	483,942	12,944	15,888	0.004
4023	LAKE MEREDITH	0.021	0.878	434,382	1,837	14,488	0.884
4024	PALESTINE LAKE	0.031	0.238	442,625	18,619	14,488	0.018
4025	PECOS [illegible] RESERVOIR	0.023	0.878	481,345	4,145	15,888	0.884
4026	SAN ANGELO RESERVOIR	0.054	0.248	481,888	24,675	18,286	0.011
4027	SAN [illegible] RESERVOIR	0.024	0.158	435,458	6,267	15,886	0.004
4028	E O SPENCE RESERVOIR	1.836	0.888	482,583	11,775	15,886	0.888

LAKE DATA TO BE USED IN [illegible]

LAKE CODE	LAKE NAME	[illegible] TOTAL P	[illegible] INORG P	SED- [illegible] SEC	[illegible] CHLPA	ZS- [illegible] M	[illegible] 1055 units -
[illegible]	SOMERVILLE LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	STAMFORD LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	STILLHOUSE [illegible] RESER	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	TEXOMA LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	TEXOMA LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]MIS LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	TRINIDAD	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	TWIN BUTTES RESERVOIR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	WHITE KING RESERVOIR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	WHITNEY LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

| | | |

PERCENT OF LAKES WITH HIGHER VALUES; NUMBER OF LAKES WITH HIGHER VALUES

LAKE ID	LAKE NAME	TOTAL P	DISSOLVED N	CHLOROPHYLL	DISSOLVED ORGANIC CARBON	SECCHI DEPTH	INDEX NO
[illegible]	[illegible]	29 (113)	55 (213)	24 (93)	1 (1)	67 (259)	39 (151)	454
[illegible]	STUMPTAIL LAKE	19 (71)	97 (371)	5 (21)	18 (71)	42 (161)	39 (144)	259
[illegible]	STILLWATER [illegible]	68 (233)	37 (141)	67 (313)	42 (154)	17 (61)	51 (199)	372
[illegible]	TAMARACK LAKE	32 (125)	78 (284)	37 (141)	21 (89)	63 (244)	58 (161)	253
[illegible]	TEARDROP LAKE	11 (44)	91 (344)	13 (51)	26 (91)	72 (279)	13 (51)	176
[illegible]	TEMPO LAKE	39 (144)	34 (133)	61 (233)	45 (171)	17 (61)	21 (71)	217
[illegible]	THAYER LAKE	68 (323)	21 (71)	42 (154)	42 (313)	17 (61)	84 (313)	384
[illegible]	THOREAU	0 (0)	91 (323)	11 (44)	5 (21)	42 (161)	0 (0)	169
[illegible]	TWIN WATTES RESERVOIR	59 (225)	21 (71)	58 (223)	91 (223)	44 (171)	63 (233)	321
[illegible]	WHITE HOUSE RESERVOIR	84 (320)	91 (223)	76 (294)	84 (344)	17 (61)	63 (233)	344
[illegible]	WHITNEY LAKE	63 (244)	91 (344)	76 (304)	71 (271)	17 (61)	76 (284)	357

[illegible]

Row	LAKE CODE	LAKE NAME	[illegible]
1	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]
6	[illegible]	[illegible]	[illegible]
7	[illegible]	[illegible]	[illegible]
8	[illegible]	[illegible]	[illegible]
9	[illegible]	[illegible]	[illegible]
10	[illegible]	[illegible]	[illegible]
11	[illegible]	[illegible]	[illegible]
12	[illegible]	[illegible]	[illegible]
13	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
15	[illegible]	[illegible]	[illegible]
16	[illegible]	[illegible]	[illegible]
17	[illegible]	[illegible]	[illegible]
18	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
20	[illegible]	[illegible]	[illegible]
21	[illegible]	[illegible]	[illegible]
22	[illegible]	[illegible]	[illegible]
23	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
25	[illegible]	[illegible]	[illegible]
26	[illegible]	[illegible]	[illegible]
27	[illegible]	[illegible]	[illegible]
28	[illegible]	[illegible]	[illegible]

[illegible] RANKED BY INDEX VAL.

RANK	LAKE CODE	LAKE NAME	INDEX VAL
29	[illegible]	[illegible]	239
30	[illegible]	[illegible]	217
31	[illegible]	[illegible]	204
32	[illegible]	[illegible]	200
33	[illegible]	[illegible]	176
34	[illegible]	[illegible]	173
35	[illegible]	[illegible]	164
36	[illegible]	[illegible]	159
37	[illegible]	[illegible]	155
38	[illegible]	[illegible]	139
39	[illegible]	[illegible]	92

APPENDIX D

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

APPENDIX D

PHYSICAL and CHEMICAL DATA

[illegible]

[illegible]

[illegible]

DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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[redacted]

[illegible]

[illegible]
31 52 05.8 094 01 24.8
[illegible]
[illegible] TEXAS

DATE	TIME	DEPTH	00010 WATER	00300	00077	00094	00400	00403	00410	00415	00418	00419	00421
FROM	OF		TEMP	DO	TRANSP	CNDUCTVY	PH	T ALK	CACO3	TOTAL	O	H+TOTAL	SUSP
TO	DAY	FEET	DEG C	MG/L	SECCHI	FIELD	SU	MG/L	MG/L	MG/L	MG/L	NG/L H	MG/L
74/03/06	10	00	0000	16.2		38	520	8.20	127	0.430	0.400	0.150	0.000
	10	00	0005	16.2	8.0		520	8.25	127	0.420	0.500	0.050	0.004
	10	00	0017	16.0	8.3		512	8.25	127	0.420	0.400	0.050	0.006
74/05/16	12	00	0000	25.4		25	495	8.30	120	0.040	0.700	0.040	0.005
	12	00	0005	25.3	7.0		493	8.30	121	0.020	0.500	0.030	0.005
	12	00	0017	25.3	7.2		490	8.30	119	0.030	0.500	0.040	0.005
74/08/06	09	40	0000	28.1	6.0	27	491	8.10	116	0.070	0.500	0.060	0.013
	09	40	0010	28.2	6.0		488	8.05	116	0.055	0.300	0.030	0.004
	09	40	0019	28.2	5.8		488	8.05	117	0.040	0.400	0.020	0.006
74/10/29	15	10	0000	19.4	7.0	38	482	8.15	99	0.060	0.400	0.060	0.012
	15	10	0005	19.4	7.0		483	8.10	97	0.060	0.400	0.060	0.021
	15	10	0015	19.4	7.4		484	8.10	98	0.050	0.400	0.050	0.029
	15	10	0017	19.4			483						
	15	10	0024	19.4			484						
	15	10	0030	19.4	6.9		483	8.00	97	0.070	0.400	0.050	0.021

DATE	TIME	DEPTH	00665 PHOS-TOT	32217 CHLRPHYL	00031 INCDT LT
FROM	OF		P	A	REMOVE
TO	DAY	FEET	MG/L P	UG/L	RECOV
74/03/06	10	00	0000	0.025	1.0	
	10	00	0005	0.025		
	10	00	0017	0.023		
74/05/16	12	00	0000	0.022	4.7	
	12	00	0005	0.019		
	12	00	0017	0.017		
74/08/06	09	40	0000	0.030	7.5	
	09	40	0010	0.024		
	09	40	0019	0.017		
74/10/29	15	10	0000	0.035	4.6	
	15	10	0003			5.0
	15	10	0005	0.036		1.0
	15	10	0015	0.035		
	15	10	0030	0.037		

APPENDIX E

TRIBUTARY DATA

[illegible]

[illegible]
[illegible]
[illegible]
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[illegible]
[illegible]

DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	OF		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	DAY	FEET	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	10	38	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	11	40	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	10	00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	10	00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	11	15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	15	30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	11	05	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	14	30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	11	30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	FEET	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FROM	OF		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TO	DAY	FEET	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]	[illegible]
FROM	OF	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TO	DAY	FEET	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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